

## HARMONIC ADDITION CIRCUIT

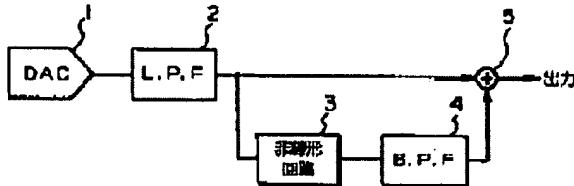
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### Abstract of JP9055634

**PROBLEM TO BE SOLVED:** To reproduce an audio signal full of natural sense by recovering a high frequency spectrum lost from the audio signal in the case of transmission or recording to an original state.

**SOLUTION:** A harmonic signal is added to a music signal by giving the music signal obtained via a DAC 1 and a low-pass filter 2 to a nonlinear circuit 3. Then a band-pass filter 4 is used to select signals at a prescribed frequency band with higher frequencies than the band of the frequency of the audio signal from an output signal of the nonlinear circuit 3 and an adder 5 adds the selected signal and the original audio signal to obtain the audio signal whose lost harmonics are recovered.



JAPANESE [JP,09-055634,A]

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CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION  
TECHNICAL PROBLEM MEANS DESCRIPTION OF DRAWINGS DRAWINGS

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## DETAILED DESCRIPTION

## Detailed Description of the Invention]

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[Field of the Invention] This invention relates to a higher-harmonic addition circuit suitable as the analog playback section of digital audio devices, such as CD and DAT.

0[ 2]

[Description of the Prior Art] As everyone knows, the spectrum of the music signal to deal with is restricted to less than 1/2 of a sampling frequency  $f_s$  on the need of preventing generating of a clinch noise in a digit audio. since [ therefore, / of CD ] the sampling frequency  $f_s$  at the time of record is 44.1kHz at a case -- record -- an object -- the spectrum of a band 22.05kHz or more is beforehand removed from a music signal (analog signal), and the digital storage to the A/D conversion and CD of a music signal with which this high region clearance was made is performed. Since the upper limit of a \*\*\*\*\* frequency is set to 20kHz with human being's lug, if it can transmit to 22.05kHz, it will be a reason for having set the sampling frequency 1 of CD to 44.1kHz that it is satisfactory.

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[Problem(s) to be Solved by the Invention] However, the spectrum of a music signal exists in 20kHz or more actually. And recently, the opinion whether the existence of the spectrum 20kHz or more which should have this \*\*\*\*\* has affected the psychology of those who listen to music is coming out. Moreover, what removed the spectrum 20kHz or more of a music signal, and the thing which is not removed are made to hear it and an electroencephalogram is investigated, although not removed, there is also a report that the direction has much generating of an alpha wave. Moreover, even if it hears the record which performs record and playback with an analog signal although it will get tired if CD which performs record and playback with a digital signal is heard for a long time while a sound is clear for a long time, fairly many men if not getting tired, and falling and attaching are in it, and as for this cause, CD also has the opinion that a real 20kHz or more is because SUPPORI has become that there is nothing.

0004] The product which adds and outputs the noise which has a spectrum 20kHz or more to the sound reproduced from CD is coming out from such a background. However, since it does not become carrying out the higher harmonic removed on the occasion of digital storage as before even if it adds a noise unrelated to such an original sound to a playback sound, there is a limitation also in taking out natureless.

0005] This invention is made in view of the situation explained above, the spectrum of a high region lost from the audio signal on the occasion of transmission or record is returned as much as possible, and it aims at offering the higher-harmonic addition circuit which can reproduce the audio signal which was rich in the natural feeling.

0006]

[Means for Solving the Problem] Invention concerning claim 1 has nonlinear transfer characteristics, and makes a summary the higher-harmonic-wave addition circuit characterized by providing the band pass filter which chooses and outputs the signal of the predetermined frequency band by the side of a high region rather than the frequency band of said audio signal from the output signal of the nonlinear circuit which adds and outputs a higher harmonic wave to an audio signal, and said nonlinear circuit, and the circuit adding said audio signal and output signal of said band pass filter.

0007] Invention concerning claim 2 makes a summary the higher-harmonic addition circuit characterized by providing the band pass filter which chooses and outputs the signal of the predetermined frequency and by the side of a high region rather than the frequency band of said audio signal from the output signal of the pitch control circuit which compresses an audio signal into time amount shaft orientations, and outputs the signal of the frequency of the integral multiple of the original frequency, and said pitch control circuit, and the circuit adding said audio signal and output signal of said band pass filter.

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[Embodiment of the Invention] Hereafter, the gestalt of operation is explained in order to make this invention further easy to understand. The gestalt of this operation cannot show one mode of this invention, cannot limit this invention, and can change it into arbitration in the range of this invention.

0009] A. The 1st operation gestalt drawing 1 is the block diagram showing the configuration of the higher-harmonic-wave addition circuit which is the 1st operation gestalt of this invention. This operation gestalt applies this invention to the part of the last stage slack analog circuit of a digital audio device, and they are DAC (digital to analog converter) from which one changes into an analog signal the digital signal reproduced from the sources, such as CD, and the low pass filter which 2 removes the spectrum of a high region of the output signal of DAC1, and outputs a smooth analog signal among drawing.

0010] 3 is a nonlinear circuit which has nonlinear transfer characteristics. As this nonlinear circuit, the circuit shown, for example in drawing 2 or drawing 4 can be used. The nonlinear circuit shown in drawing 2 is a detector circuit, and as shown in drawing 3, it outputs only a polar fixed signal among input signals. Moreover, the nonlinear circuit shown in drawing 4 is a clipping circuit, as shown in drawing 5, it is outputted as it is about the signal in an input signal and below fixed level, and it is stopped and outputted to fixed level about the part exceeding fixed level.

0011] In drawing 1, 4 is a band pass filter for choosing the spectrum of a high region from an audible frequency range among the output signals of a nonlinear circuit 3, for example, has the 20kHz - 100kHz passband or the 20kHz - 150kHz passband. 5 is an adder which adds the output signal of a band pass filter 4, and the output signal of a low pass filter 2, and is supplied to a loudspeaker (graphic display abbreviation).

0012] According to the above configuration, the music signal (analog signal) outputted through DAC1 and the low pass filter 2 is inputted into a nonlinear circuit 3, turns into a signal including the higher harmonic of the frequency of the integral multiple of a music signal besides an original music signal, and is outputted from a nonlinear circuit 3. The spectrum by the side of a high region is chosen from an audible frequency range with a band pass filter 4 among the output signals of this nonlinear circuit 3, and it is added to the original music signal by the adder 5, and is outputted.

0013] The spectrum added to the music signal of the origin of this has the frequency of the integral multiple of the music signal outputted from a low pass filter 2, and is considered to be what is more equivalent to the higher harmonic by the side of a high region than the spectrum removed in advance of digital storage, i.e., the audible frequency range included in the original music signal. Therefore, according to this higher-harmonic-wave addition circuit, the analog signal near the original music signal in front of digital storage will be outputted from an adder 5.

0014] B. Although the higher harmonic wave over a music signal was added by the analog circuit with the operation gestalt of the 2nd operation gestalt above 1st, a digital circuit performs this processing with this 2nd operation gestalt.

0015] In performing D/A conversion in a digital audio, in order to simplify the design of the analog low pass filter for low-pass filtration of the analog signal after D/A conversion, it is common to insert a digital filter with an exaggerated sampling function in the preceding paragraph of DAC.

0016] This operation gestalt is established between this DAC and a digital filter, and has the configuration shown in drawing 6. In this drawing, 1 is DAC and 6 is the above-mentioned digital filter. And 7 is a nonlinear circuit which has nonlinear transfer characteristics, and adds and outputs a higher harmonic to the digital music signal outputted from a digital filter 6. 8 is a band pass filter for choosing the spectrum of a high region from an audible frequency range among the output signals of a nonlinear circuit 7. And 9 is an adder which adds the output signal of a band pass filter 8, and the output signal of a digital filter 6, and is supplied to DAC1.

0017] As for the digital music signal reproduced from CD etc., according to the above configuration, the exaggerated sampling of the sampling frequency is increased by the digital filter 6 4 times or 8 times. Therefore, even if the sampling frequency  $f_s$  of the digital music signal reproduced from CD etc. is 44.1kHz, in order that DAC1 the very thing may operate by one 4 times or 8 times the sampling frequency of this, even if it generates a higher harmonic 20kHz or more with a nonlinear circuit 7 and a band pass filter 8, a problem is not produced at all.

0018] C. The 3rd operation gestalt drawing 7 is the block diagram showing the configuration of the higher-harmonic-wave addition circuit which is the 3rd operation gestalt of this invention. This higher-harmonic-addition circuit forms the adder 13 adding the pitch control circuits 10-12 and these output signals instead of the nonlinear circuit 7 in the operation gestalt ( drawing 6 ) of the above 2nd. Here, the pitch control circuits 10-12 compress into time amount shaft orientations the digital music signal which a digital filter 6

outputs using a ring buffer, and output it respectively as a wave-like digital signal of one the twice of the original frequency, 3 times, and 4 times the frequency of this. The output signal of each pitch control circuit is given to a band pass filter 8 through an adder 13. About other actuation, it is the same as that of the operation gestalt of the above 2nd. Also in this operation gestalt, the same effectiveness as the operation gestalt of the above 2nd is acquired.

0019] D. In addition, although the various operation gestalten of this invention were explained above, the applicability of this invention is not restricted to the field of a digital audio, and may be realized in the transmission system which transmits a sound signal like a telephone using a narrow band with the gestalt of adding the higher harmonic removed in advance of transmission in a receiving side. moreover, as having clarified this invention also in each above-mentioned operation gestalt -- digital one and an analog -- it is applicable to any transmission system.

0020]

Effect of the Invention] Since a higher harmonic wave is generated and it was made to add from the reproduced audio signal according to this invention as explained above, it will add to the audio signal after reproducing the thing near the higher-harmonic-wave signal removed from the original audio signal on the occasions, such as digital storage, and is effective in the audio signal which was rich in the natural feeling i.e., reproducible.

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